

**THAT WHICH IS CLAIMED IS:**

1. A sorbent composition suitable for removal of elemental sulfur and sulfur compounds from cracked-gasolines and diesel fuels which is comprised of:

- (a) zinc oxide;
- (b) expanded perlite;
- (c) an aluminate; and
- (d) a promoter metal

wherein said promoter metal is present in an amount which will effect the removal of sulfur from a stream of cracked-gasoline or diesel fuel when contacted with the same under desulfurization conditions and at least a portion of said promoter metal is present in a zero valence state.

2. A sorbent composition in accordance with claim 1 wherein said promoter metal is at least one metal selected from the group consisting of nickel, cobalt, iron, manganese, copper, zinc, molybdenum, tungsten, silver, antimony, and vanadium.

3. A sorbent composition in accordance with claim 2 wherein said promoter metal is present in an amount in the range of about 1.0 to about 60 weight percent.

4. A sorbent composition in accordance with claim 4 wherein said zinc oxide is present in an amount in the range of about 10 to about 90 weight percent

and said expanded perlite is present in an amount in the range of about 10 to about 40 weight percent.

5. A sorbent composition in accordance with claim 1 wherein said promoter metal is nickel.

6. A sorbent composition in accordance with claim 1 wherein said promoter metal is cobalt.

7. A sorbent composition in accordance with claim 1 wherein said promoter metal is a mixture of nickel and cobalt.

8. A sorbent composition in accordance with claim 1 wherein said aluminate comprises said promoter metal.

9. A sorbent composition in accordance with claim 8 wherein said promoter metal is at least one metal selected from the group consisting of nickel, cobalt, iron, manganese, copper, zinc, molybdenum, tungsten, silver, antimony, and vanadium.

10. A sorbent composition in accordance with claim 9 wherein said promoter metal is nickel.

11. A sorbent composition in accordance with claim 1 wherein said aluminate comprises zinc.

12. A sorbent composition in accordance with claim 8 wherein said aluminate comprises zinc.

13. A sorbent composition in accordance with claim 9 wherein said aluminate comprises zinc.

14. A sorbent composition in accordance with claim 10 wherein said aluminate comprises zinc.

15. A sorbent composition suitable for removal of elemental sulfur and sulfur compounds from cracked-gasolines and diesel fuels which is comprised of:

(a) zinc oxide;

(b) expanded perlite; and

(c) a substitutional solid metal solution of a promoter metal and zinc wherein said substitutional solid metal solution is present in an amount which will effect the removal of sulfur from a stream of cracked-gasoline or diesel fuel when contacted with the same under desulfurization conditions and at least a portion of said substitutional solid metal solution is present in a zero valence state.

16. A sorbent composition in accordance with claim 15 wherein said promoter metal is at least one metal selected from the group consisting of nickel, cobalt, iron, manganese, copper, zinc, molybdenum, tungsten, silver, antimony, and vanadium.

17. A sorbent composition in accordance with claim 16 wherein said promoter metal is present in an amount in the range of about 1.0 to about 60 weight percent.

18. A sorbent composition in accordance with claim 17 wherein said zinc oxide is present in an amount in the range of about 10 to about 90 weight percent and said expanded perlite is present in an amount in the range of about 10 to about 40.

19. A sorbent composition in accordance with claim 15 wherein said promoter metal is nickel.

20. A sorbent composition in accordance with claim 15 wherein said promoter metal is cobalt.

21. A sorbent composition in accordance with claim 15 wherein said promoter metal is a mixture of nickel and cobalt.

22. A sorbent composition comprising:

(a) zinc oxide;

(b) a substitutional solid metal solution of a promoter metal and zinc wherein said substitutional solid metal solution is present in an amount which will effect the removal of sulfur from a stream of cracked-gasoline or diesel fuel when contacted with the same under desulfurization conditions, at least a portion of said substitutional solid metal solution is present in a zero valence state, and said promoter metal is at least one metal selected from the group consisting of nickel, cobalt, iron, manganese, copper, zinc, molybdenum, tungsten, silver, antimony, and vanadium.

23. A sorbent composition in accordance with claim 22 wherein said promoter metal is present in an amount in the range of about 1.0 to about 60 weight

percent and said zinc oxide is present in an amount in the range of about 10 to about 90 weight percent.

24. A sorbent composition in accordance with claim 23 further comprising expanded perlite in an amount in the range of 10 to about 40 weight percent.

25. A sorbent composition in accordance with claim 24 wherein said promoter metal is nickel.

26. A sorbent composition in accordance with claim 24 wherein said promoter metal is cobalt.

27. A sorbent composition in accordance with claim 24 wherein said promoter metal is a mixture of nickel and cobalt.

28. A sorbent composition comprising:

(a) zinc oxide; and

(b) a promoter metal-zinc aluminate substitutional solid solution

characterized by the formula  $M_ZZn_{(1-Z)}Al_2O_4$

wherein M is a promoter metal selected from the group consisting of nickel, cobalt, iron, manganese, copper, zinc, molybdenum, tungsten, silver, antimony, and vanadium and Z is a numerical value in the range of from 0.01 to 0.99.

29. A sorbent composition in accordance with claim 28 wherein said promoter metal is nickel.

30. A sorbent composition in accordance with claim 28 further comprising a substitutional solid metal solution of said promoter metal and zinc.

31. A sorbent composition in accordance with claim 30 wherein said promoter metal is nickel.

32. A sorbent composition in accordance with claim 28 further comprising expanded perlite.

33. A sorbent composition in accordance with claim 32 wherein said zinc oxide is present in an amount in the range of about 10 to about 90 weight percent and said expanded perlite is present in an amount in the range of about 10 to about 40 weight percent.

34. A sorbent composition in accordance with claim 33 wherein said promoter metal is nickel.

35. An oxidized sorbent composition comprising:

(a) zinc oxide; and

(b) a substitutional solid metal oxide solution

wherein said substitutional solid metal oxide solution is characterized by the formula  $M_XZn_YO$ , wherein M is a promoter metal and X and Y are each numerical values in the range of from 0.01 to 0.99.

36. An oxidized sorbent composition in accordance with claim 35 wherein X is in the range of about 0.50 to about 0.90 and Z is in the range of about 0.10 and 0.50.

37. An oxidized sorbent composition in accordance with claim 36 wherein M is a metal selected from the group consisting of nickel, cobalt, iron, manganese, copper, zinc, molybdenum, tungsten, silver, antimony, and vanadium.

38. An oxidized sorbent composition in accordance with claim 35 wherein X is in the range of about 0.60 and about 0.80 and Y is equal to about (1-X).

39. An oxidized sorbent composition in accordance with claim 38 wherein M is nickel.

40. An oxidized sorbent composition in accordance with claim 35 wherein said zinc oxide is present in an amount in the range of about 10 to about 90 weight percent and said substitutional solid metal oxide solution is present in an amount in the range of about 5 to about 70 weight percent.

41. An oxidized sorbent composition in accordance with claim 35 further comprising a promoter metal-zinc aluminate substitutional solid solution characterized by the formula  $M_ZZn_{(1-Z)}Al_2O_4$ , wherein M is said promoter metal and Z is a numerical value in the range of from 0.01 to 0.99.

42. An oxidized sorbent composition in accordance with claim 41 wherein M is a metal selected from the group consisting of nickel, cobalt, iron, manganese, copper, zinc, molybdenum, tungsten, silver, antimony, and vanadium.

43. An oxidized sorbent composition in accordance with claim 41 wherein M is nickel.

44. An oxidized sorbent composition in accordance with claim 41 wherein said zinc oxide is present in an amount in the range of about 10 to about 90 weight percent, said substitutional solid metal oxide solution is present in an amount in the range of about 5 to about 70 weight percent, and said promoter metal-zinc aluminate substitutional solid solution is present in an amount in the range of about 2 to about 50 weight percent.

45. An oxidized sorbent composition in accordance with claim 35 further comprising expanded perlite.

46. An oxidized sorbent composition in accordance with claim 40 further comprising expanded perlite in an amount in the range of about 10 to about 20 weight percent.

47. An oxidized sorbent composition in accordance with claim 41 further comprising expanded perlite.

48. An oxidized sorbent composition in accordance with claim 44 further comprising expanded perlite in an amount in the range of about 10 to about 20 weight percent.

49. A reduced sorbent composition comprising:

- (a) zinc oxide; and
- (b) a substitutional solid metal solution



wherein said substitutional solid metal solution is characterized by the formula  $M_AZn_B$ , wherein M is a promoter metal and A and B are each numerical values in the range of 0.01 to 0.99.

50. A reduced sorbent composition in accordance with claim 49 wherein A is in the range of from about 0.50 to about 0.97 and B is in the range of from about 0.03 to about 0.50.

51. A reduced sorbent composition in accordance with claim 50 wherein M is a metal selected from the group consisting of nickel, cobalt, iron, manganese, copper, zinc, molybdenum, tungsten, silver, antimony, and vanadium.

52. A reduced sorbent composition in accordance with claim 49 wherein A is in the range of from about 0.80 to about 0.95 and B is equal to about (1-A).

53. A reduced sorbent composition in accordance with claim 52 wherein M is nickel.

54. A reduced sorbent composition in accordance with claim 49 wherein zinc oxide is present in an amount in the range of about 10 to about 90 weight percent and said substitutional solid metal solution is present in an amount in the range of about 5 to about 80 weight percent.

55. A reduced sorbent composition in accordance with claim 49 further comprising a promoter metal-zinc aluminate substitutional solid solution

characterized by the formula  $M_ZZn_{(1-Z)}Al_2O_4$ , wherein M is said promoter metal and Z is a numerical value in the range of from 0.01 to 0.99.

56. A reduced sorbent composition in accordance with claim 55 wherein M is a metal selected from the group consisting of nickel, cobalt, iron, manganese, copper, zinc, molybdenum, tungsten, silver, antimony, and vanadium.

57. A reduced sorbent composition in accordance with claim 55 wherein M is nickel.

58. A reduced sorbent composition in accordance with claim 55 wherein said zinc oxide is present in an amount in the range of about 10 to about 90 weight percent, said substitutional solid metal solution is present in an amount in the range of about 5 to about 80 weight percent, and said promoter metal-zinc aluminate substitutional solid solution is present in an amount in the range of from about 2 to about 50 weight percent.

59. A reduced sorbent composition in accordance with claim 49 further comprising expanded perlite.

60. A reduced sorbent composition in accordance with claim 54 further comprising expanded perlite in an amount in the range of from about 2 to about 50 weight percent.

61. A reduced sorbent composition in accordance with claim 55 further comprising expanded perlite.

62. A reduced sorbent composition in accordance with claim 58 further comprising expanded perlite in an amount in the range of from about 2 to about 50 weight percent.

63. A composition comprising desulfurized cracked-gasoline wherein said desulfurized cracked-gasoline comprises less than about 1 ppmw thiol compounds and less than about 1 ppmw tetrahydrothiophene compounds.

64. Composition in accordance with claim 63 wherein said desulfurized cracked-gasoline has a decrease in average octane number, as determined by  $\Delta(\text{RON}+\text{MON})/2$ , of less than 3.5.

65. Composition in accordance with claim 63 wherein said desulfurized cracked-gasoline comprises less than about 0.5 ppmw thiol compounds and less than about 0.5 ppmw tetrahydrothiophene compounds.

66. Composition in accordance with claim 63 wherein said desulfurized cracked-gasoline comprises less than about 1 ppmw dihydrobenzothiophene compounds.

67. Composition in accordance with claim 63 wherein said desulfurized cracked-gasoline has a decrease in average octane number, as determined by  $\Delta(\text{RON}+\text{MON})/2$ , of less than 3.

68. Composition in accordance with claim 63 wherein said desulfurized cracked-gasoline comprises less than about 25 ppmw sulfur.

69. Composition in accordance with claim 63 wherein said desulfurized cracked-gasoline comprises less than about 15 ppmw sulfur.